PRIVATE INDIVIDUAL SERVICES

IN THE RURAL AREA

SUMMARY REPORT

FOR DISCUSSION

Original Report prepared by:

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and
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May, 1992

Prepared for: Regional Municipality of
Ottawa-Carleton and
the Ministry of Municipal Affairs

NOTE:

This summary has been compiled by the staff of the Planning Department of the Regional Municipality of Ottawa-Carleton. However, it reflects, very closely, the Executive Summary of the Consultants' report. It is intended to reflect the recommendations made in that document.

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1.0 INTRODUCTION

1.1 OBJECTIVE OF STUDY

This study was prepared to advise municipalities on a number of issues related to rural development on private services.

Groundwater use in Canada is growing, having doubled between 1966 and 1985. As further growth occurs and competing pressures for rural land uses multiply, the potential for groundwater depletion and contamination could increase in the absence of adequate preventive measures.

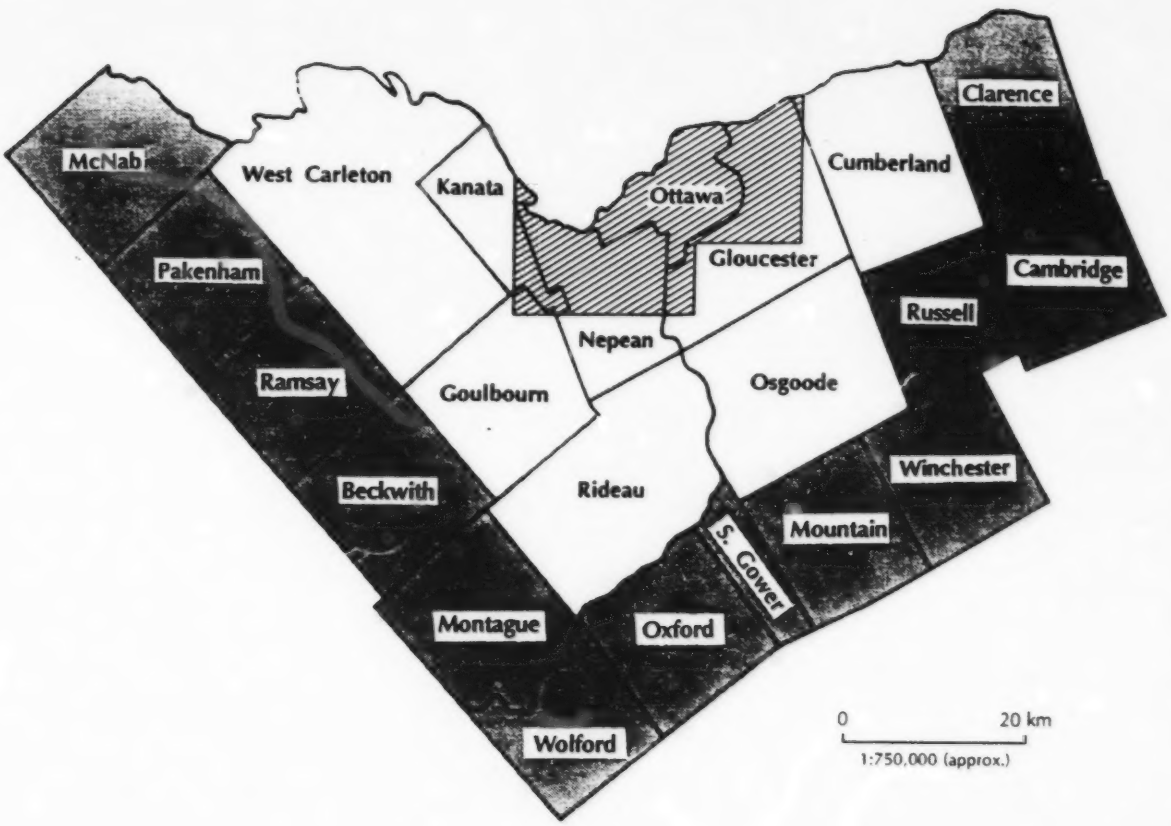
An increasing number of groundwater problems are being documented in Ontario. A survey of 560 wells in the Regional Municipality of Waterloo indicated that 68% of the dug wells and 22% of the drilled wells had bacterial contamination with 29% of the dug wells and 3% of drilled wells exhibiting nitrate levels in excess of 10 mg/L. Similar results have been encountered within a portion of the area studied for this report. The Leeds, Grenville and Lanark District Health Unit reported that 19.4% of 6,115 samples taken in 1990 were "bacteriologically unsafe for drinking water purposes due to the presence of fecal coliform organisms". The same agency reported that 14.2% of 712 samples had nitrate levels in excess of 5 mg/L with 4.1% of those exceeding the Provincial drinking water objective of 10 mg/L.

The consultants were requested to examine a number of matters related to private servicing with the overall objective of providing direction to ensure the long term protection of the groundwater reserves. These matters relate to the regulatory environment for private services and some specific hydrogeological characteristics of the study area.

1.2 STUDY AREA

The study was prepared by Geo-analysis Inc. and J.L. Richards and Associates Limited on behalf of the Ontario Ministry of Municipal Affairs (MMA) and the Regional Municipality of Ottawa-Carleton (RMOC) to evaluate the potential for safe growth in the rural areas of the Ottawa-Carleton and the surrounding townships. A significant portion of the study area population (approximately 18% in 1988) depends on groundwater.

The study area includes the 21 municipalities identified on Figure 1a and listed below:



URBAN AREA EXCLUDED FROM STUDY AREA

REGIONAL MUNICIPALITY OF OTTAWA-CARLETON

TOWNSHIPS SURROUNDING RMOC

Figure 1a

Study Area Map

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RMOC	SURROUNDING AREAS
Cumberland	Beckwith
Gloucester	Cambridge
Goulbourn	Clarence
Kanata	McNab
Nepean	Montagne
Osgoode	Mountain
Rideau	Oxford-on-Rideau
West Carleton	Pakenham
	Ramsay
	Russell
	South Gower
	Winchester
	Wolford

The urban area inside the limits of the Greenbelt has been excluded from the study.

1.3 DATA SOURCES AND METHODOLOGY

The study relied on existing information to arrive at recommendations on policies and practices that should be implemented to ensure safe and appropriate rural development on private individual services. Among them are:

- Published geologic maps and reports;
- 200 hydrogeologic reports completed to support subdivision applications; and
- 21,000 water well records held by the Ministry of the Environment.

The above information was analysed using a Geographic Information System (GIS) to outline the geological and hydrogeological characteristics of the study area.

1.4 SUMMARY REPORT FORMAT

This summary report outlines the salient issues and recommendations of the main study report dated May 1992. It is organized as follows:

- Water Quantity and Quality
- Wells and Heat Pumps
- Private Sewage Disposal
- Cummulative Impact
- Rural Development Policies

Figures used in the Summary document have been selected from the

original report so that the numbering sequence may at times seem incomplete.

2.0 WATER QUANTITY AND QUALITY

2.1 WATER QUANTITY

An aquifer is a geological unit capable of yielding water to a well. The study area is underlain by various aquifers including several bedrock aquifers, basal gravel aquifers and overburden aquifers. Well yield provided on a daily basis by the underlying aquifers is, in most cases, sufficient to meet existing residential demand.

2.2 WATER QUALITY

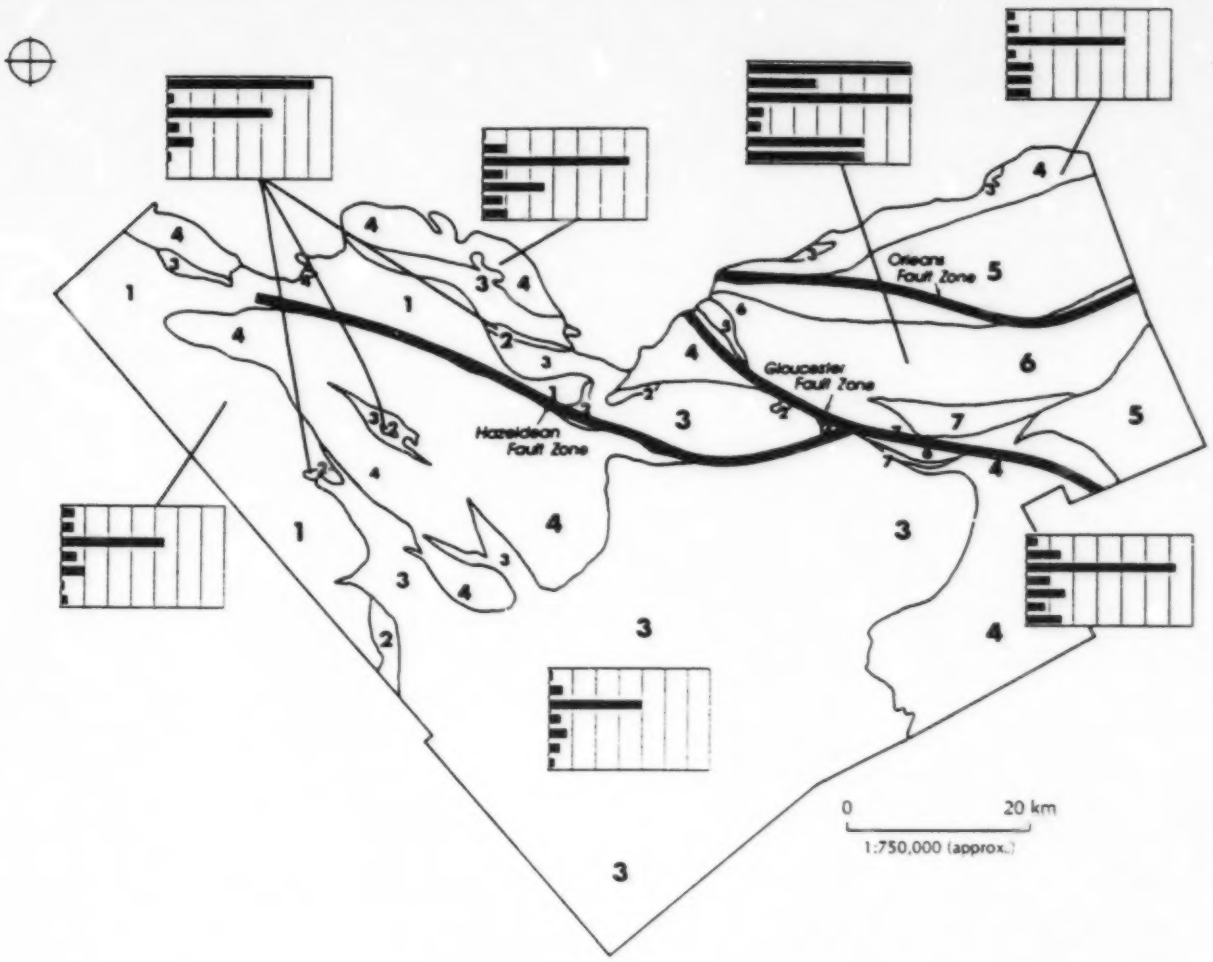
Natural water quality is of potable composition in most of the study area, with randomly occurring pockets having aesthetic parameters which exceed the Ontario Drinking Water Objectives. Water of a non-potable nature is found more commonly in bedrock aquifers in the eastern one third of the study area and in selected reaches along the Ottawa River, where pockets of saline groundwater are found. Overburden sources of good quality are found locally. No widespread anthropogenic contamination in the aquifers is documented. Locally, septic system contaminant problems exist, particularly in those areas where overburden is thin and/or where the same geological unit is used as a source of water and as a sink for septic system effluent (see Figures 4a and 4b).

2.2.1 Groundwater Chemical Composition

The compilation of water well records has shown that the general groundwater flow direction is easterly in the bedrock aquifer. This flow is affected locally by fault boundaries and geological contacts. The geological information for the study area shows that the bedrock geology in the study area gets progressively younger going east, and the lithology changes from sandstones, to carbonates, to shales.

As the shale content increases, so does the mineral content of the water supply. The concentration of total dissolved solids changes abruptly with the crossing of fault boundaries suggesting little connection between fault blocks. The major flow trends in each block have been identified in Figure 8b.

The areas which have a higher potential to be of poor water quality in the bedrock due to shales have been shown in

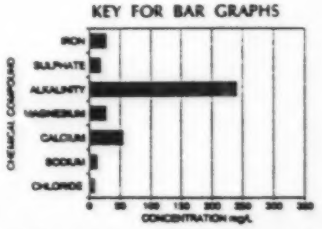


Data Source: Selected Hydrogeological reports submitted for subdivision approval.

	BEDROCK GEOLOGY	GIS RANKING
7	RED SHALES	4
6	GREY SHALES	4
5	INTERBEDDED LIMESTONE & SHALE	4
4	LIMESTONE and a little shale	2
3	DOLOMITE & LIMESTONE	1
2	SANDSTONE	1
1	IGNEOUS AND METAMORPHIC	3

Adapted: Williams and others (Ontario Geological Survey - Paleozoic Series)

KEY FOR BAR GRAPHS



For illustration purposes, iron concentrations have been increased by a factor of 100

Water quality distribution is associated to typical aquifer blocks. Variations will occur locally.

Figure 4a
Water Quality Distribution of the Bedrock Aquifers

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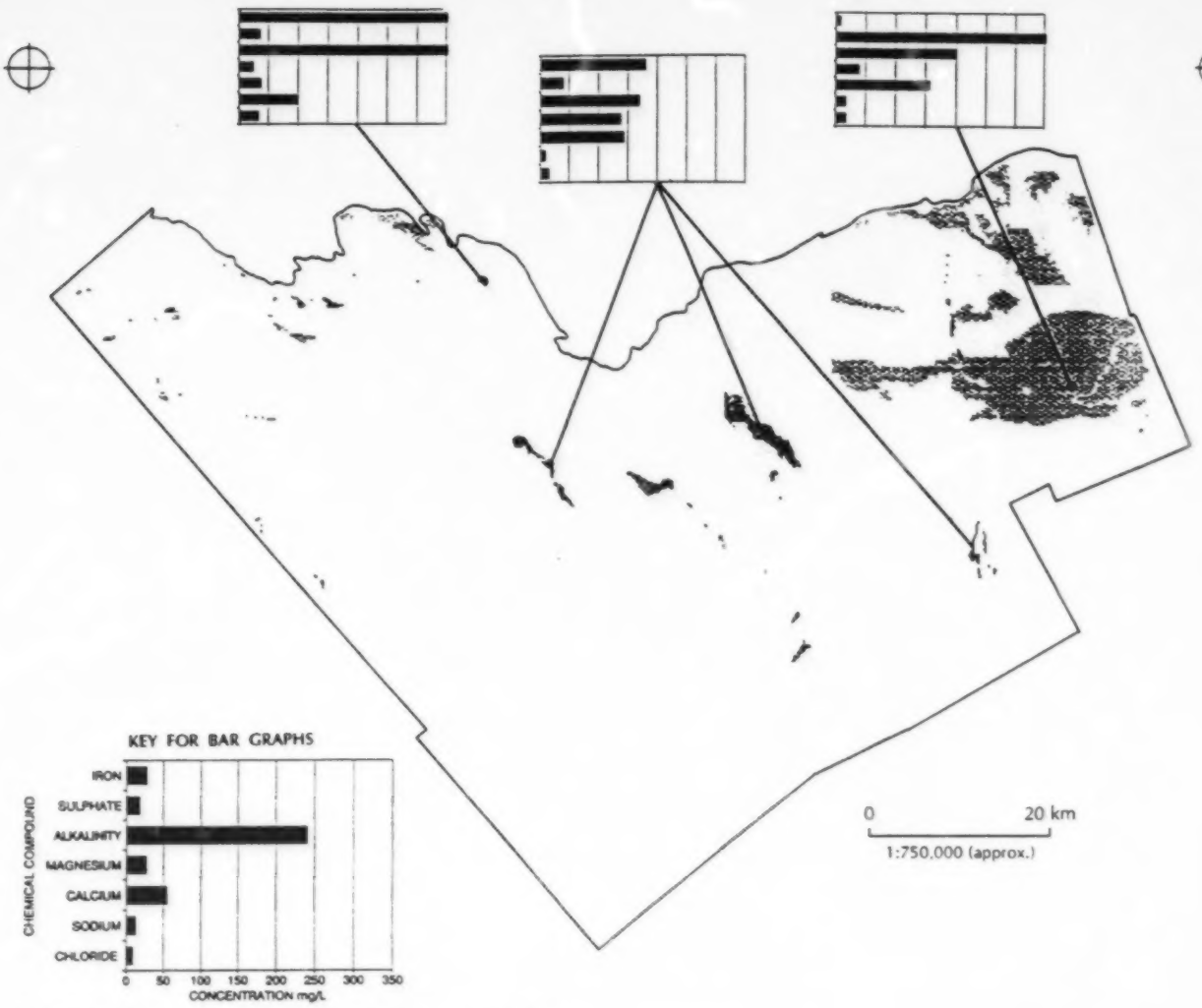

For illustration purposes, Iron concentrations have been increased by a factor of 100

OVERBURDEN AQUIFERS	POTENTIAL	GIS RANKING
ICE CONTACT - stratified drift	High	1
DELTAIC & ESTUARINE SEDIMENTS	Moderate	2
ALLUVIUM & NEARSHORE SEDIMENTS	Low	3
Remaining Overburden Units & Bedrock Outcrops	Unclassified	4

Notes:

1- Basel Gravel Aquifer may be present in places.

2- Saturated portions of Alluvium & Nearshore Sediments may limit its Overburden Potential.

Figure 4b
Water Quality Distribution of the Overburden Aquifers

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Potentiometric Surface (m geodetic)

- 180 +
- 140 - 180
- 100 - 140
- 70 - 100
- <70

FLOW TRENDS

AQUIFER BLOCKS
(Fault Boundaries)

Data Source: MOE Waterwell Records (approx.18,000 wells)

Figure 8b

Potentiometric Head of Bedrock Aquifer and Groundwater Flow Trends

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Figure 4a. Discussions with local drillers indicate that in these poorer quality areas, the least mineralized water will be found at shallow depths and that deeper drilling will only yield more saline waters.

2.2.2. Impact of Settlement on Water Quality

A survey of study area Health Department/Units and MOE offices was conducted to identify any anthropogenic (i.e. man induced) impact on groundwater resources. Problems reported include:

Elevated Nitrate: which is attributed to septic system impact, although in some instances may be due to agricultural activities.

Elevated Bacteria: which is attributed to septic system impact.

Elevated Salt: road salting activities or natural background of aquifer.

Hydrocarbon Contamination: leaking underground storage tanks, heating oil, etc.

Organic Solvents: septic tank cleaners (eg. TCE).

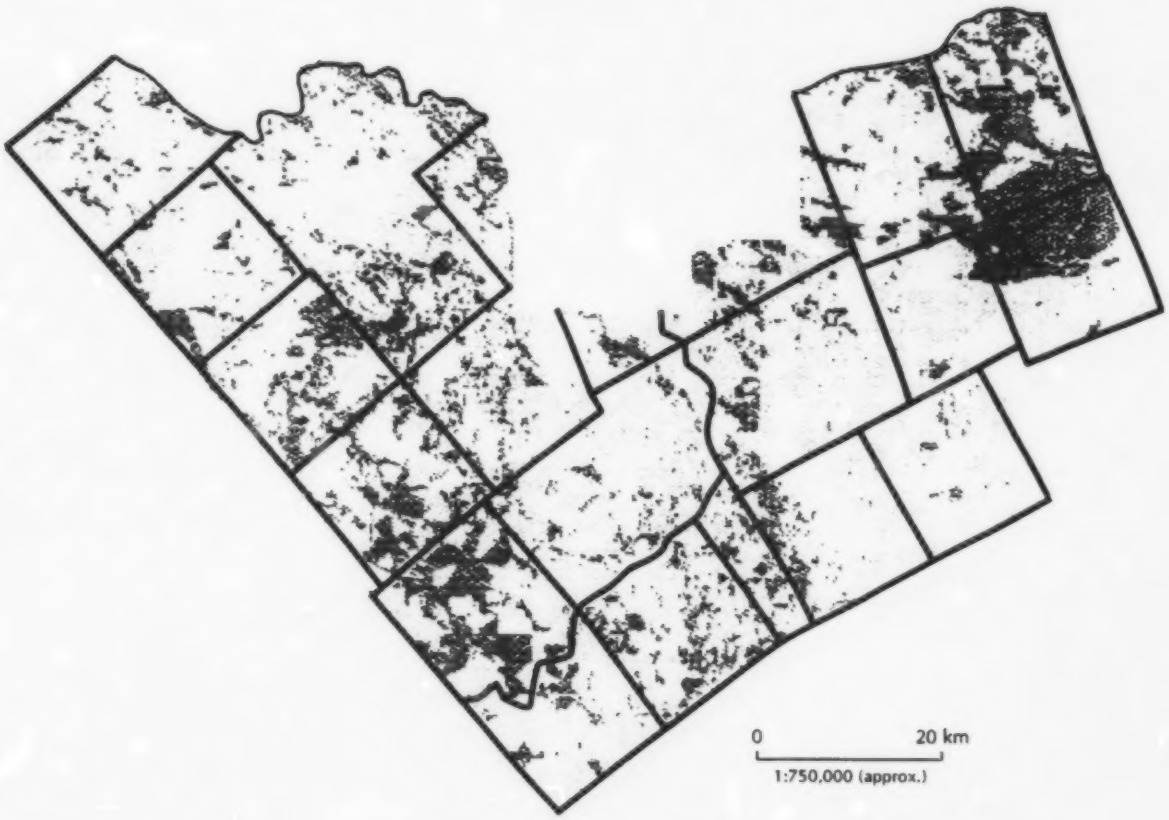
These problems are particularly aggravated in areas of thin overburden, and where the surficial unit is utilized as the aquifer.

It is noted that no comprehensive regional water quality surveys exist to document the complete state of groundwater supply. It is felt that there is the potential for serious undocumented water quality contamination in parts of the study area. An extensive water quality survey of existing wells should therefore be undertaken in order to obtain a more complete view of this issue.

2.3 AQUIFER RECHARGE AREAS

Bedrock aquifer groundwater recharge probabilities are identified on Figure 14. Major recharge areas need to be protected from high risk land uses and properly managed in order to ensure the sustainability of groundwater quality.

In principle, the entire influence area around a drinking water supply source should be protected against any change in the properties of existing background groundwater. Protection of groundwater is essential as clean up and rehabilitation are costly. However, the large scale utilization of the fractured



Recharge Probability

- VERY HIGH
- HIGH
- MODERATE
- LOW

Data Source:
MOE Waterwell Records (current to 1985)

NOTE:
See Appendix G for Modelling Methodology

Figure 14

Bedrock Aquifer Groundwater Recharge Probability Map

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bedrock makes it difficult to establish precise capture zones. Cases are known where interference of pumping is felt kilometres away in one specific direction. There are also areas which are particularly prone to contamination due to their short flow path to the aquifer. These areas include the areas of high recharge probability and shallow overburden aquifers.

Land uses that are considered a threat to aquifer recharge areas include:

- "High density" sewage disposal (lot areas smaller than those recommended in this report);
- Domestic and industrial solid waste disposal;
- Uncontrolled agricultural practices;
- Industrial activity (eg. underground spills);
- Storage facilities for potential contaminants;
- Transportation corridors (e.g. surface spills, road salting); and
- Aggregate extraction activities (recharge interference, fuel spills, illegal dumping).

In areas of development pressure, water budget studies are essential. Growth on private water supplies will have a very limited effect on the regional groundwater supply in areas where relatively thick overburden is present. However, this may not be the case for areas situated in shallow overburden. Future work should include the evaluation of:

- flow mechanisms;
- long term yield studies;
- the nature of the connection between the main hydrogeological units;
- the degree of urbanization and its effect on recharge;
- the aquifer boundaries;
- the aquifer block flow time;
- hydrogeochemical patterns within each groundwater system;
- expected isotope signals for flowsystem and groundwater age evaluation;
- additional numerical modelling of densely developed areas.

In addition, the Ontario Government should consider the establishment of well head protection legislation as has been done in Europe and in the U.S.A.

Due to the susceptibility of the aquifer to contamination in recharge areas, development on private services should be discouraged in these areas. Furthermore we recommend that a "watch dog" monitoring system be developed for the above identified pollution sources to safeguard the groundwater resources. Municipalities should take leadership in monitoring

these activities and their impacts on the groundwater. The application of Reasonable Use Criteria should be enforced on new developments. Developments belonging to this group should be allowed to proceed only on the presentation of a satisfactory impact review and a satisfactory contingency plan.

2.4 EXISTING WATER QUALITY GUIDELINES FOR SUBDIVISION APPROVAL

2.4.1 Water Quality Guidelines in Ontario

In Ontario, drinking water objectives have been designed primarily for the protection of public health. These objectives are generally intended for municipal and/or private communal water supplies (i.e. water systems serving more than five private residences). However, these objectives also state that it is desirable that the water quality of private supplies should not be inferior to that of public supplies. A subset of these guidelines are used by the Ontario Ministry of the Environment in the "Guidelines for New Subdivision Developments on Private Services" (October 29, 1990). A list of health-related bacteriological parameters is provided in Table 2. Organic compounds and other contaminants (e.g. heavy metals) were not made part of the list as they are not a widespread problem with the exception of some suspect areas where these compounds are handled. It is the Ministry of Environment's opinion that it is up to the consultant that does the hydrogeological assessment of the proposed development to assess if there is the potential of these compounds to be present. If so, they should be analyzed and included in the assessment.

Both health related and aesthetic quality parameters are included in the subdivision list. The subdivision list of Ontario Drinking Water Objectives for health and aesthetic parameters has to be satisfied in order for a subdivision proposal to be viewed favourably by the MOE for approval. If the health parameters are not satisfied, the MOE will recommend against the approval of the subdivision. If the health parameters are satisfied but there are problems with the aesthetic quality, treatment of the water within specified limits can be considered as a possible remedy to improving the quality. Favourable consideration of the subdivision in this situation will be dependent upon the decision of the Local or Regional Municipality to share the responsibility for ensuring the formulation and carrying out of the terms of the subdivision agreement (i.e. notice for the provision of a treatment system and/or water quality information).

TABLE 2

- HEALTH-RELATED BACTERIOLOGICAL PARAMETERS

Parameter	MOE Objective*	Comments
Fecal coliforms	0	Pathogens and indicators of fecal contamination
Fecal streptococci	0	
Total coliforms	<5	Indicators of possible or potential contamination

* The MOE Objectives are expressed as the plate count per 100 ml of sample.

* The above objectives are for water considered SAFE for drinking

- HEALTH-RELATED CHEMICAL PARAMETERS

Parameter *	MOE Objective	Comments
Sodium (Na)	-	levels may be of interest to authorities who wish to prescribe low sodium diets for their patients
Fluoride (F)	2.4 mg/l	excesses may cause fluorosis
Nitrate (NO3)	10.0 mg/l	contamination indicator; excess dangerous to infants
Nitrite (NO2)	1.0 mg/l	contamination indicator
Turbidity **	1 F.T.U.	could indicate problems in well construction or a naturally occurring problem

* other parameters may be added when appropriate

** test parameters must be reported in proper units. If units of measure do not match the units presented above, conversion ratios should be provided.

TABLE 2 cont.

COMMONLY OCCURRING AESTHETIC CHEMICAL PARAMETERS AND POLLUTION INDICATORS

Parameter *	Comments For Symptoms	Maximum Desirable Concentration (1)	Maximum Concentration Considered Reasonably Treatable (2)	Comments on Treatment
Chloride	Associated with salt problems	250 mg/l	Compliance	**
Colour	-	5 T.C.U. (True Colour Units)	7 T.C.U.	On the basis of a Carbon Filter Treatment System Capability
Iron	Excesses cause staining of plumbing fixtures and laundry	0.3 mg/l	up to 5.0 mg/l	By Water Softeners or Manganese Greensand Filters
			> 5.0 mg/l to 10.0 mg/l	Air Oxidation with filtration through proprietary filter media or Chlorination followed by sand or multi-media filtration
Manganese	Excesses cause staining of plumbing fixtures and laundry	0.05 mg/l	1.0 mg/l	By Water Softeners or Manganese Greensand Filters
Methane	-	3.0 l/m3	Compliance	**
Phenol	-	0.002 mg/l	0.05 mg/l	Chlorination and Post Carbon Filtration
Sulphate	-	500 mg/l	Compliance	**
Sulphide	Determine on fresh sample	0.05 mg/l as H2S (inoffensive) (1A)	1.0 mg/l	By Chlorination (up to 0.3 mg/l) or Manganese Greensand Filters or Proprietary Media Filters
Tastes & Odour	Site specific,	inoffensive	-	-
T.D.S. Total Dissolved Solids	Considered an indicator of possible problems with dissolved components	500 mg/l	-	Requires written assurance (with rationale)that problems associated with taste, solids, precipitation or corrosivity will not occur

mg/l=milligrams per litre, l/m3=litres per cubic metre

COMMONLY OCCURRING AESTHETIC CHEMICAL PARAMETERS AND POLLUTION INDICATORS (CONTINUED)

Parameter *	Comments For Symptoms	Maximum Desirable Concentration (1)	Maximum Concentration Considered Reasonably Treatable (2)	Comments on Treatment
Conductivity	-	M.D.C. for TDS= 500 mg/l 0.65(+0.10)x Conductivity = TDS limit	-	-
Ammonia	Contamination indicator	-	-	-
Background Bacteria	Contamination indicator	-	-	-
Tannins	Contamination indicator	-	-	-
T.O.C. Total Organic Carbon	-	5.0 mg/l as C	10.0 mg/l as C	By Carbon Filter
pH	6.5-8.5 desirable range	-	-	-
Calcium	Associated with mineral Scaling problems	-	-	-
Magnesium	Associated with mineral scaling problems	-	-	-
Alkalinity	Associated with mineral scaling problems	-	-	-
Hardness	< 200 mg/l desirable, taste	-	-	-

mg/l=milligrams per litre

* Other parameters may be added when appropriate or at the discretion of the consultant

** Compliance with drinking water objectives since an economically feasible water treatment system does not exist

NOTE: References

(1) - Ontario Drinking Water Objectives (Green Book, Revised 1983 ISBN 0-7743-895-0)

(1A) - Guidelines For Canadian Drinking Water Quality (1987 Health and Welfare Canada, ISBN 0-66012644-3)

(2) - Reasonable for Whole House Water Supply, no unusual space or backwash requirement and system must be in relatively common, widespread use (Provided by Water Resources Branch of the Ministry of the Environment)

NOTE: Treatment systems requiring backwash facilities will be considered on the basis of proven well yield capabilities of 17 litres per minute or greater

Treatment limits established by the MOE are shown in Table 2. Communal or individual treatment systems can be considered. If individual systems are to be utilized and the concentrations of the aesthetic parameters exceed the limit considered treatable, the approval of the subdivision will not be recommended. For communal treatments, a communal water supply would be utilized and the approval would then be based on requirements for water works as defined under the Ontario Water Resources Act.

2.4.2 Comparison With Other Water Quality Guidelines

The MOE objectives for water quality for subdivisions were compared with limits set by the United States Environmental Protection Agency (USEPA), the European Economic Community (EEC) and the World Health Organization (WHO). These values have been provided in Table 3. The limits from the other organizations have been established for public supplies and not necessarily for subdivisions with individual wells.

The limits from the other organizations are generally no more stringent than the MOE objectives. The health related parameters are similar for all organizations. The fluoride value varies from 1.5 to 4.0 mg/L. The MOE value is in the middle at 2.4 mg/L. The turbidity value for the MOE is lowest with a value of 1 NTU (Nephelometric Turbidity Unit), the others vary from 1 to 5 NTU.

The aesthetic parameters show more variability. For total dissolved solids, hardness, and colour, the MOE limits (including the treatability limit for colour) are more stringent than the criteria from the other organizations. For iron, manganese and phenols, the maximum desirable concentrations are less stringent than the other groups' criteria.

2.4.3 Recommendation

When a groundwater source meets the health related parameters but the aesthetic parameters fall short of meeting the Ontario Drinking Water Objectives, it is recommended that it be accepted only if one parameter lies in the treatability range. Experience has shown that when more than one parameter exceeds the limit, treatment interference may occur with commercial units. Even if no treatability limits have been set for hardness and sodium, it is recommended that their presence be accounted for in the treatment assessment. A tehcnical review of treatment systems must be performed for each individual case where more than one parameter falls in the treatability range. The rationale pertains to their ability to perform on a long term basis with low cost and simple maintenance. This

Parameter							
MOE Subdivision List	MOE	Notes	EEC	Notes	USEPA	WHO	Notes
HEALTH RELATED PARAMETERS	**MAC**		**MAC**		**MAC**	**GV**	
Bacteriological							
Plate Count per,100 ml							
Total coliforms	<5		< 1		1	10	
INORGANIC PARAMETERS							
Sodium (mg/l)		20 mg/l health advisory		20 mg/l health advisory		200	taste consideration
Fluoride (mg/l)	2.4		1.5		1.4-2.4	1.5	guideline
Nitrate (mg/l)	10	expressed as N	50	expressed as Nitrate	10	10	
Nitrite (mg/l)	1	expressed as N	0.1	expressed as Nitrite	1	1	
Turbidity (NTU)	1		10 mg/l Silicate		1-5	5	less 1 with disinfection
AESTHETIC PARAMETERS	**MDC**	**MCCRT**	**GL**		**IND MCL**	**GV**	
Total Dissolved Solids (mg/l)	500	excess needs written assurance	400	in S/cm	500	500-1500	
Ammonia(mg/l)		contamination indicator	0.5				
Background Bacteria(p.co. 100ml)		contamination indicator	10 @ 37C	100 @ 22C			
Tannins (mg/l)		contamination indicator					
Total Organic Carbon(mg/l)	5	up to 10 treatable		any increase has to be investigated			investigate changes in levels
pH	6.5-8.5		9.5		6.5-8.5	6.5-8.5	
Calcium (mg/l)		Refer to table 2					
Magnesium (mg/l)		Refer to table 2	50				
Alkalinity (mg/l)		Refer to table 2	30	Minimum required			
Hardness (mg/l)		Refer to table 2	60	Minimum required		500	
Chloride (mg/l)	250				250	250	
Colour (TCU)	5	up to 7 treatable	20		15	15	
Iron(mg/l)	0.3	up to 10 treatable	0.2		0.3	0.3	
Manganese (mg/l)	0.5	up to 1 treatable	0.05		0.05	0.1	
Methane (l/m3)	3						
Phenol (mg/l)	0.002	up to 0.05 treatable	0.005			0.001	For chlorinated waters
Sulphate (mg/l)	500		250		250	400	
Sulphide (mg/l)	0.05	up to 1.0 treatable	No odour		non detectable	non detectable	
Taste	inoffensive		2 @ 12C 3 @ 25C	Dilution #		non offensive	
Odour	inoffensive		same as taste		3	non offensive	

References: Canadian Council of Resource and Environment Ministers, 1987. Canadian Water Quality Guidelines. Environment Canada

Carney, M., 1991 European Drinking Water Guidelines. J AWWA 1991

MOE, 1991. Guideline Water Supply for New Subdivision Development on Private Services. Ministry of the Environment South Eastern Region

Sayre, I. M., 1987 International Standards for Drinking Water. J. AWWA

USEPA, 1990. Fact Sheet, Drinking Water Regulations Under the Safe Drinking Water Act. USEPA Criteria and Standards Division Office of Drinking Water

WHO, 1984. Guidelines for Drinking Water Quality Volume 1 Recommendations. World Health Organization

TABLE 3

Existing Water Quality Guidelines

GEOANALYSIS

performance review should be completed by qualified process engineers and will require written assurance of reliability with a bench test treatment.

In areas with a high potential to be affected by industrial or farming activities, it is recommended that the drinking water guideline list be expanded to include the following: pesticides (from ODWO list), volatile organics (from USEPA list) and other inorganics (from USEPA list).

Septic tank cleansers such as TCE contribute organic solvents to groundwater supplies. As in some northeastern states of the U.S.A., TCE based solvents used as cleansers for septic systems should be prohibited in the study area.

This study does not recommend any changes to the concentration guidelines for health related parameters established by MOE.

3.0 WELLS AND HEAT PUMPS

3.1 WELL CONSTRUCTION

The sustainability of development based on private services depends upon the control of well construction techniques. It is recommended that more inspections of well construction be conducted with emphasis on grouting (i.e. ensuring complete circulation ofthe grout mixture in the annular space, bottom upwards) and proper casing installation. A minimum of 6 m of grouted casing should be used.

Well construction in Ontario is regulated by MOE Regulation 612/84. Regulation 612/84 stipulates well construction techniques and regulations to protect the safe-use of the groundwater resource. The MOE South Eastern Region enforces this regulation reactively. That is the MOE will respond to complaints of possible violation with an investigation. A proactive enforcement would be desirable. The reactive level of control has likely resulted in unnoticed improper grouting and casing installation in some wells by drillers. One improperly completed well in a densely developed subdivision normally goes unseen for years until damage to the aquifer has occurred.

The Regulation furthermore requires that, with the construction of each well, the installer is to complete a well record. This system works fine for wells completed in the bedrock, however for some reason not all completed overburden wells are registered. This pertains mostly to the overburden wells that have been constructed by other methods than drilling. A scatter plot of the bedrock wells and overburden wells in the Ministry records

(Figures 7 and 8) reveals that in some areas of known overburden aquifer utilization, no water well records are available. One such area is found in Cambridge Township, where numerous sandpoints are installed and no well reports are found.

In order to control well construction, some area municipalities have adopted well compliance Regulations. The driller and homeowner sign a document to confirm that the well has been drilled according to the Township's Regulation. All municipalities with such a program report a low cost of record keeping and a good response rate. However, no field control of well construction compliance is conducted.

Lot layout in all development should ensure that the location of wells is:

a) upgradient from the lot's septic system;
b) outside the 10 mg/L nitrate plume; and
c) not directly downgradient from an adjacent property's septic system.

The completion of a well with an adequate supply of potable water should be included as a condition of all consent approvals which create new building lots. The one year period to prove this capability before the consent lapses is more than adequate. An unsuspecting purchaser should not be burdened with the responsibility of finding potable water after the deed for a new lot has been stamped.

3.2 HEAT PUMPS

A moratorium on the use of groundwater heat pumps should be put in effect until controlled and regulated. Furthermore it should be ensured that groundwater heat pump use will not adversely affect potable water quality. This could possible be achieved by a control on water quality of all water bearing zones and the bypassing of drinking water supply zones. Furthermore it should be assured that the systems utilized for heat pump use can not introduce foreign compounds into the groundwater.

The Executive Director of the Canadian Earth Energy Association indicated in late 1991 that 22,500 earth energy systems have been installed in Canada since 1979, as many as 1,000 in the Township of West Carleton alone.

Groundwater heat pumps require a large flow either through pumping or heat exchange by brines or methanol. This flow is typically equivalent to 3 times the flow for a domestic supply. The present method of heat pump installation does not control or monitor the water quality before and after the installation.

The large volume requirements encourage the deepening of wells, with the intersection of several water bearing zones, promoting the mixing of varying quality groundwater and the possible contamination of potable upper zones.

In addition, water quality changes due to aeration caused by some heat exchangers, the potential for contamination for coiled based equipment (eg. brines and methanol), temperature changes and increased water demand stress on the aquifer, are suggested as issues for future investigations. Ontario Hydro and MOE should cooperate to regulate this conflicting use of the groundwater.

4.0 PRIVATE SEWAGE DISPOSAL

Domestic sewage effluent released into the leaching bed of a septic system has the potential to contain a variety of contaminants, including nitrates and organic solvents (eg. TCE from certain septic tank cleaners). The persistence of nitrate in groundwater makes it the critical contaminant. Nitrates have therefore been utilized in the evaluation of septic system impact.

Conventional septic systems are designed as effluent disposal systems. They provide treatment against Biochemical Oxygen Demand (BOD) and bacteria, but provide very little removal of nitrogen. In areas of high density development therefore, septic system contaminants, in particular nitrates, may find their way in groundwater resources.

Information provided by staff of local Health Units/Departments and the MOE identify the following as the most common septic system problems:

1) Nitrate pollution
2) Bacteriological problems
3) Undocumented viral contamination
4) Hydraulic failure of a septic bed

Presently the MOE is rewriting its regulations for the construction of septic systems. It appears that the MOE's preference is municipally owned and operated communal systems to service future development. Consideration has been given to the following three options:

1) mandatory impact assessment of septic system effluent for each leaching bed using the Ontario Drinking Water Objectives;

2) mandatory impact assessment of septic system effluent

for eachleaching bed using the Reasonable Use Criteria; and

3) no more approvals of conventional waste disposal system.

4.1 SEPTIC SYSTEM IMPACT ASSESSMENT

Where servicing occurs by private individual septic systems, two limiting design criteria will dictate the impact on the environment. These two criteria include excessive hydraulic mounding in low permeability soils (eg. effluent breakout of the surface) and excessive nitrate loading in permeable soils (eg. downgradient groundwater contamination). Sustainable development should take the following three criteria into account:

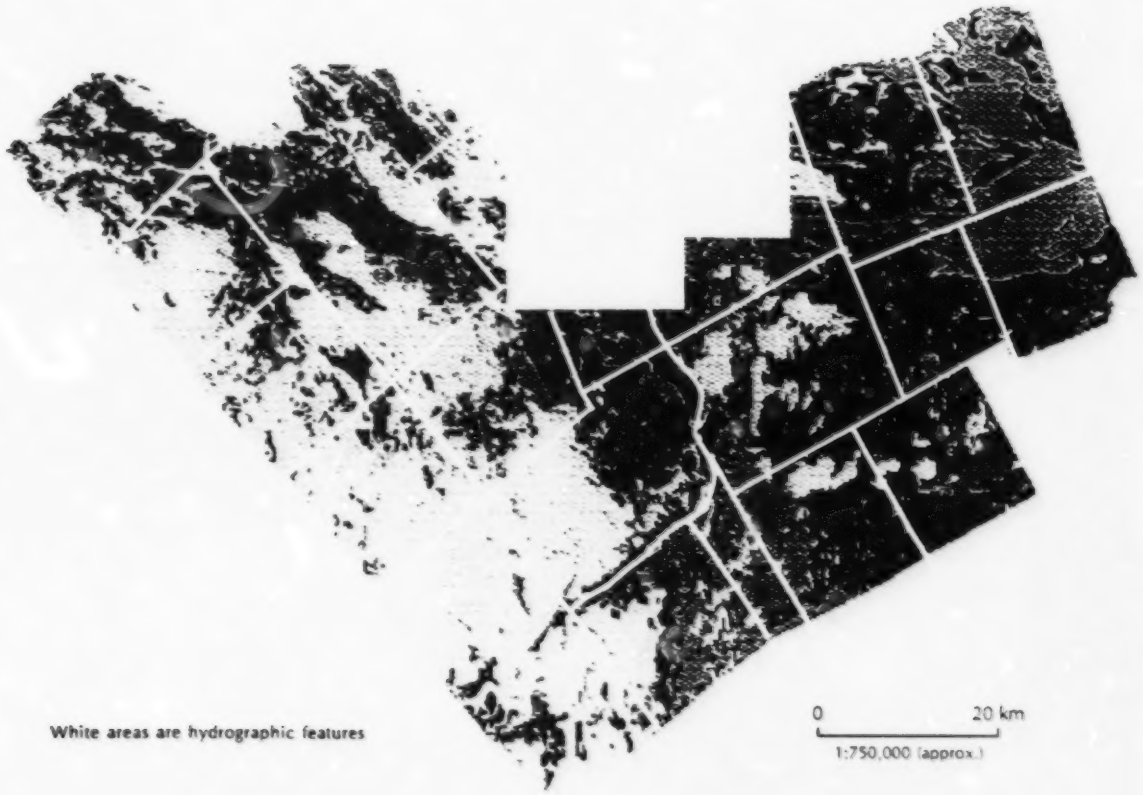
1)The ability of the overburden to transmit the sewage effluent;
2)The ability of any underlying materials to protect the aquifer; and
3)The ability of the hydrogeological systems to ensure acceptable cumulative impact.

In the study area, typical terrains consist of thick clays, thick tills, thick sands used as aquifers, thin sands overlying clays and thin sands overlying bedrock. Mounding computation and flowthrough assessments of nitrate loading should be completed on all terrain to determine which parameter is the limiting design criterion. This determination needs to be made as early in the development process as possible.

4.2 LOT SIZE DETERMINATION

The protection of the aquifer as a potable groundwater resource is the main focus underlying the terrain suitability potential for septic systems map (Figure 17). The best areas basically consist of thick, low hydraulic conductivity soils which offer a natural safeguard to the protection of any underlying aquifers. In CERTAIN places, the thick clay will be overlain by higher hydraulic conductivity soils which do not have an aquifer potential. In these terrain conditions, where the underlying aquifer is good, the lot size will be approximately 1.0 ha based on mounding calculations.

It is recommended that within this study area, 1.2 m of mineral unsaturated soil be present in the leaching bed area. When low hydraulic conductivity soil is present, lot size should be determined by mounding calculations. This will typically result in lots of 1.5 to 2.1 ha in size. Caution should be given to fractures and fissures in the clays, particularly in thin deposits. The bulk hydraulic conductivity may behave more like a



White areas are hydrographic features

0 20 km

1:750,000 (approx.)

TERRAIN SUITABILITY	GIS RANKING
HIGH	1
MODERATE	2
LOW	3
VERY LOW	4

NOTES:

1) Classification is based on protecting the underlying Aquifer.

2) The modelled overburden thickness does not take into account the stratigraphic sequence. Site specific studies are required and may vary from the above classification.

3) Based on conventional septic systems.

4) See Appendix H for Modelling Methodology

Figure 17

Terrain Suitability Potential for Septic Systems

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granular material in which case plume delineation should be determined.

Considering that the State of New Hampshire has a minimum lot size of 2.0 ha for private services, and that the West Central MOE Region is doing similar impact assessment yielding large lot sizes in thick permeable soils and that the Southeastern MOE Region has recently adopted 1 ha typical lot size in the February 1992 MOE workshop in Kingston, it appears that the lot sizes derived in this present study are corroborated.

However, any proposed development on private individual services on specific terrain conditions may differ from these recommendations. It is recommended that development on marginal terrain be phased in order to observe actual results before allowing subsequent phases of the developments (say 20 lots or 50% of the subdivision). The location of services should be based on field evidence of shallow groundwater flow characteristics. It is understood that, in certain circumstances, the 2 year monitoring period could be replaced adequately by the monitoring of existing nearby septic systems.

4.3 ALTERNATIVE TECHNOLOGIES

Alternative technologies are being developed to treat septic system effluent. These systems provide a level of treatment of septic system effluent and require less area to reduce loading of the systems to background levels. As these alternative technologies become accepted by the Ontario regulatory agencies, lot sizes could be reduced, as less area is required for dilution.

A non-exhaustive listing of alternative treatment systems include the following:

a) Aquarobics: A mini nitification-denitrification plant, where the end result is treated effluent to near background levels. Presently, the plants are expensive (in excess of $10,000) and require substantial maintenance, and as such they are not ready for widespread applications.

b) Class 6 System: Several units are available that reduce the BOD of the effluent. Nitrate treatment is not provided, however, and the question of dilution still remains.

c) Peat Beds: A specific grade of peat is used to provide a treatment of effluent. The system is successful in reducing nitrate to within Reasonable Use levels. Costs are similar to conventional systems and the source materials are abundant in Southeastern Ontario. The State of Maine has

accepted this system for sewage disposal and treatment. Some pilot projects are underway in Ontario. Peat beds appear to offer the greatest potential for treatment. This may imply that, once accepted, lot size requirements on permeable soil may be reduced significantly from the sizes proposed in this document.

Until new technologies are approved in Ontario, conventional septic systems developed on permeable soils will generate plumes, and large lots will be required. Interim options to large, individually serviced lots may include the following:

a) Moratorium on privately serviced development;
b) Communal systems - A cluster of residents could be hooked up to a central treatment plant (MOE would currently require that the municipality maintain or be ultimately responsible for it);
c) Holding tanks - The municipality contracts with a hauler and the pumped sewage is hauled to a sewage treatment plant or lagoon maintained by the Municipality (this assumes that reserve capacity is available at nearby sewage treatement plants and that the municipality is willing to accept it); and
d)Greater emphasis is placed on fully serviced planned development.

5.0 CUMULATIVE IMPACT AND DISTRIBUTION OF RURAL DEVELOPMENT

5.1 CUMULATIVE IMPACT

Three years ago, a 0.2 ha lot size was common for many rural developments, especially hamlets. As previous sections have shown, large lot sizes are desired to minimize potential negative impact from septic systems on the groundwater supply. Since 1988, when the Reasonable Use Criteria was adopted, (but no area designated for subdivision approval), impact assessment has been required by MOE Southeast Regional hydrogeologists on a case by case basis. The sustainability of development was usually not considered with regards to cumulative effect of neighbouring subdivisions.

On the groundwater supply aspect, a review of in excess of 200 subdivision reports in the study area has shown that long term groundwater demand and interference are usually assessed by questionable methodology. Main weak areas for the assessment of groundwater supply include:

a) Pump tests are performed for too short a duration to determine aquifer boundary conditions;
b) Pump tests are not performed at aquifer capacity; therefore, theoretical estimates of aquifer parameters are unreliable;
c) Water quality changes due to development are not addressed; and
d) Raw water quality is not compared with existing adjacent property wells.

The effects on existing and future development should typically address two main areas, namely impacts created due to the exploitation of the groundwater resources and those due to contamination caused by the operation of septic systems.

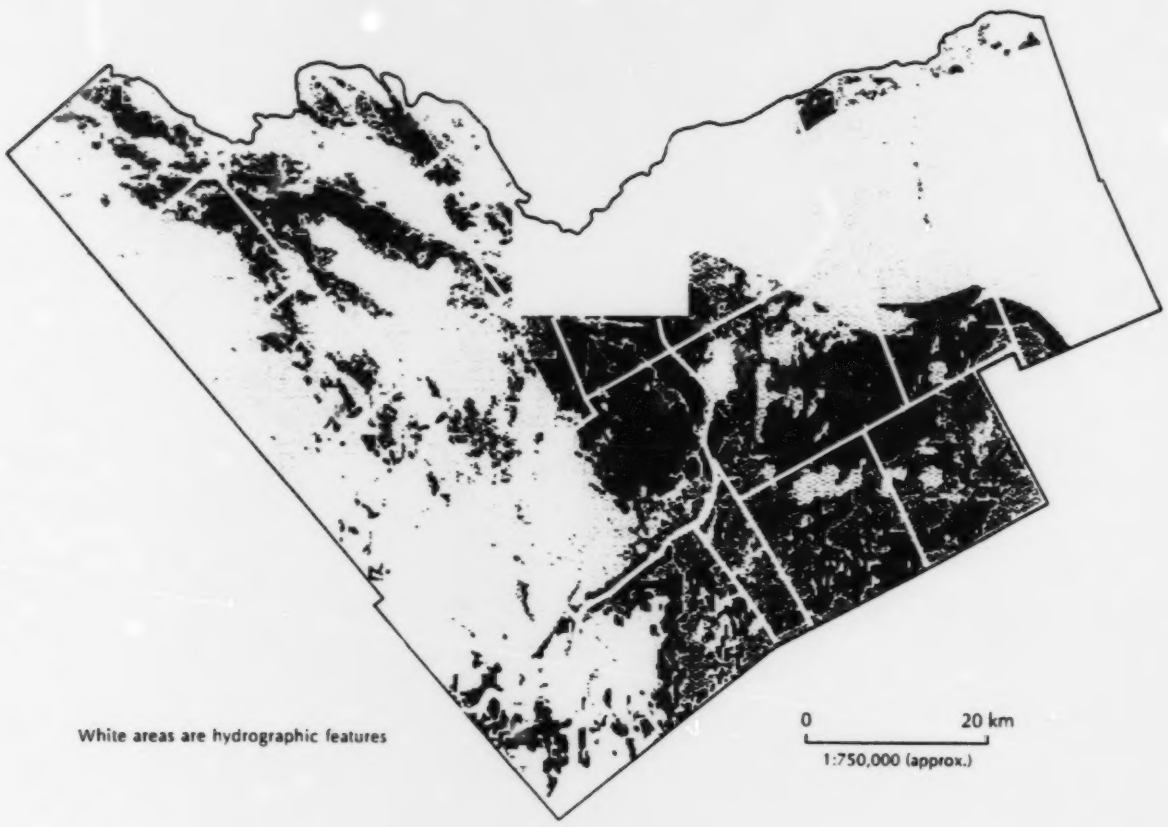
A development potential map has been generated for the study area (see Figure 18). It identifies areas where sustainable development on private individual services can be encouraged. Development on private individual services should be discouraged in areas where natural continuous soil thicknesses are less than 1.2 m. Development on private individual services should not be allowed in areas where natural continuous soil thicknesses are less than 0.3 m. Until alternate technologies are approved by the Regulators, sustainable development on permeable soils will demand large lots, particularly where the upper formation has potential to be used as an aquifer. The best terrain for development consists of thick fine grained soil where the bedrock is the regional aquifer.

5.2 RECOMMENDATIONS

Ideally the minimum requirements to assess cumulative impact should address the following:

1) For Water Supply:
   a) Aquifer boundary conditions;
   b) Aquifer long term sources
      i.e. - Leakage from upper aquifers
           - Surface waters
           - Infiltration
   c) Changes in water quality due to pumping by exhaustive surveys of existing nearby wells;
   d) Effects on existing users;
   e) Calculations and methodology to address hydraulic impacts.

2) For Septic Systems:
   a) Nitrate loading to the shallow groundwater and aquifer and surface water on and off site;
   b) Other contaminant loading to the shallow groundwater



DEVELOPMENT POTENTIAL	GIS RANKING
HIGH	1
MODERATE	2
LOW	3

NOTE:
1) See Appendix I for Modelling Methodology.
2) Figure based on Aquifer Potential and Terrain Suitability.

Figure 18

Development Potential Map

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and surface water (if applicable);
c)Determine flow paths of contaminants prior to development and after development ;
d)Mounding calculations;
e)Determine the appropriate lot size based on the detailed study.

In order to be able to assess changes due to development, sampling stations should be set up in undeveloped areas and developed areas. Cost of these monitoring stations should be borne by the developer. Upon acceptance of the subdivision, ownership of these wells should be transferred to the municipality. These locations should be monitored for changes in base level of the aquifer and in the quality of the water supply.

Presently, the RMOC has a guideline of 40 lots at a time per subdivision applications. It may be desirable to review the impact of development on a 20 lot phasing, and of one development on other developments. This phasing should take into account the site's hydrogeologic conditions in the lot layout. Contiguous developments should not take place until the performance of the wells and septic systems from the existing nearby development has been assessed.

In order to ensure the integration of cumulative impact considerations in the creation of future lots with sustainable individual private services in the rural area, the Reasonable Use Criteria should apply for the creation of new lots sized with the flowthrough method (i.e. 2.5 mg/L nitrate), where the overburden is used as an aquifer. It also means that no significant hydraulic head generated by the septic system mounding would permit a flow of effluent onto neighbouring land. Development density limitation is the only control that will allow the cumulative impact to be acceptable.

New development adjacent to an existing subdivision should only be permitted if it meets the following criteria:

a) The existing phased subdivision should be sufficiently developed to demonstrate its ability to function on a sustainable basis;
b) Groundwater quantity and quality at the earlier phase of the subdivision are performing as expected; and
c) Monitored mounding and nitrate loading are better than simulated.

Also, documentation of the aquifer behaviour should be initiated for long term monitoring. This could typically include the installation of wells in the several available aquifers in strategic locations. These wells should be provided by

developers and ownership transferred to the municipality which will manage a network of monitoring points. Furthermore, these stations could be monitored to document water quality changes with aquifer use. Further study should be undertaken to address the following issues:

- Detailed documentation of aquifer flow;
- Determination of effects on flow patterns with increased urbanization;
- Determination of water quality changes brought about by developments;
- Determination of long term groundwater level changes as a result of development;
- Determination of guidelines for groundwater heat pumps;
- Determination of aquifer replenishment cycles; and
- Creation of long term aquifer gauging stations

6.0 RURAL DEVELOPMENT POLICIES

The previous sections of this report have drawn conclusions and offered recommendations on how water quality and quantity, well construction, sewage system installation, aquifer recharge and cumulative impacts can be addressed. The aggregate conclusion, based on these factors, is an obvious need for more comprehensive hydrogeological investigation to support specific development proposals, combined with a significant increase in lot sizes, if sustainable development (using current technology) is to be accommodated in the rural areas.

The rural development policy implications of the foregoing conclusions and recommendations are outlined in this section.

6.1 CONCLUSIONS

a. The Official Plan policies of the study area municipalities do not clearly state the long term goals for groundwater protection and back them up with clear implementation strategies. The Official Plan of the Regional Municipality of Ottawa-Carleton goes the furthest towards this end but retains significant gaps.

b. The Provincial Ministry of the Environment is overloaded and will probably never be able to deal effectively with all the groundwater issues in Ontario's municipalities. Regulation of activities which impact upon groundwater is already fragmented and incomplete. No agency broadly assesses, plans, monitors and comprehensively deals with groundwater. Inside the Region, the Ministry of the Environment contracts

out septic system approvals to private consulting firms. In the balance of the study area, the Health Units handle this responsibility. In most of the study area, no well construction supervision occurs except for test wells in subdivisions supervised by the applicant's hydrogeologist.

c. The Ministry of the Environment's policy (requiring 1 ha lots) is not technically defensible since it does not address nitrate plumes and groundwater flow direction issues. Instead, it emphasizes a greater dilution objective in the hope that at least massive problems will not occur. The real issue is the need for better private sewage treatment rather than more dispersed sewage disiposal (dilution).

d. The GIS modelling results identified both conflicts and consistencies with existing planning approaches for rural areas. Figure 18 shows a major conflict between potential development and agricultural land preservation because good agricultural soils are best suited for development. Of lesser significance are the conflicts between aggregate extraction and groundwater quality/quantity preservation due to interference with water tables, storage of fuels, etc. Even the potential extraction of peat for peat beds (presuming these are approved as alternative sewage treatment systems) conflicts with wetland preservation.

e. On the other hand, consistency is also found. Figure 18 also shows that areas like the thin soils of the Carp Hills, designated Marginal Resource Area (Restricted) in the Regional Official Plan, have low capability for development on private services. Similarly, wetland areas have low potential for development and often form an important part of the groundwater recharge system. The effective incorporation of hydrogeological concerns into the rural planning process will require earlier consideration of these elements in conjunction with these other policy issues.

6.2 RECOMMENDATIONS

a. The Regional Municipality of Ottawa-Carleton should take a leadership role in the study area and further refine, manage and supplement the information contained in the Aquifer Management System. Although the Ontario Water Resources Act states that the Minister of the Environment is responsible for the supervision of all groundwater in Ontario, the Planning Act assigns responsibility to local government to ensure the health and safety of the future inhabitants. Increasingly, the results of inaction are likely to be costs borne by local taxpayers. The Regional Municipality of

Ottawa-Carleton is in the process of setting up its own Geographically Referenced Information System (GRIS). A logical next step is to incorporate the aquifer management system in the GRIS and to continue to upgrade the aquifer management system within the GRIS tool. The Regional Municipality should make the information generated available to the Health Units and abutting municipalities. At an appropriate time in the future, the Health Units may wish to establish their own systems.

b. The Regional Municipality of Ottawa-Carleton should consider employing its own qualified hydrogeologist. The management of the study area's groundwater resources requires the attention of qualified individuals who can conduct relevant research, collate data, produce useful results, monitor well construction, sewage disposal system installations and septage application/disposal sites, coordinate public education programs or develop new programs such as sewage disposal system remediation or mandatory inspection of systems when a home is resold and generally deal with the multitude of matters which ultimately impact upon the sustainable use of groundwater resources. Some of the costs could be recouped through application fees or inspection fees.

c. The Ministry of the Environment should increase its efforts to conduct research on alternative sewage treatment technologies and assist the municipalities in the development of effective policy approaches.

d. While isolated groundwater problems exist, there is not such a sense of urgency that drastic measures such as Interim Control By-laws are required. However, planning policies need to more comprehensively deal with groundwater protection than they have in the past.

e. The creation of small lots in hamlets on private services should be immediately curtailed pending a full investigation of servicing implications.

f. The potential use of communal water systems in the rural area should be considered by the study area municipalities in location where site specific high yield capability is available since they offer the ability to be more closely controlled during construction, allow for ongoing monitoring by a public agency and provide an opportunity for communal treatment where required.

g. A terms of reference for adequate and reasonable hydrogeological investigations should be developed for the

study area, in consultation with representatives of the hydrogeology firms working in the area. This is the approach used by the Regional Municipality of Waterloo in developing its terms of reference.

h. There is a great need for provincial sensitivity to the problems of local land use planning, requiring more assistance and less obstructionism, and recognizing the legitimate growth pressures which exist. Cooperative leadership is required and consistency in the way that Ministry policies are applied throughout the study area (inside RMOC and outside). It is a paradox that provincial assistance is more readily available for groundwater clean up than it is for prevention. It is strongly recommended that the provincial government give serious consideration to assistance programs for serviced development, rather than limiting itself to partial assistance for the expansion of overloaded servicing systems.

i. A strict licensing procedure should be developed to ensure that all new wells are tested and all investigation results are submitted to the "Regional Hydrogeologist". This will help ensure a complete database.

   A licensing procedure should be developed to ensure that handlers/users of potential contaminants exercise an appropriate level of caution.

j. Approval policies for privately serviced development should focus on environmental compatibility, based on continuing research. Mitigation and buffering techniques should be explored. The purchase of down gradient development rights could be considered or designs could ensure that only parks and open space uses occur in potential impact areas. Phases smaller than 40 lots should be considered (about 20 lots) with detailed monitoring policies enforced as a prerequisite to additional development.

k. A comprehensive well water survey should be undertaken in the study area to determine the overall status of drinking water quality.

l. A monitoring program should be established to determine whether private sewage disposal systems in approved subdivisions are performing in the manner predicted by the hydrogeology studies.

m. Well head protection measures should be undertaken to ensure that existing communal water supply systems can continue to function safely and economically.

n. Subdivision application forms and applicant guidelines should be revised to stress the importance of adequate hydrogeological information at the earliest stages of the rural development process.

o. Multiple consents should be severely limited. The consent process was simply not designed to deal with the complexities of multiple lot developments. The subdivision process requires corresponding improvement so that the multiple consent process is not such an attractive alternative.

p. The creation of single lots by consent should involve the collection of basic information on soil type, groundwater flow direction and proximity to wells and sewage disposal systems on neighbouring lots in areas where development exists or is anticipated. In isolated circumstances, such as a farm retirement lot, or for very large lots, this information may be less critical. There is no technical justification for the creation of inferior lots through the consent process.